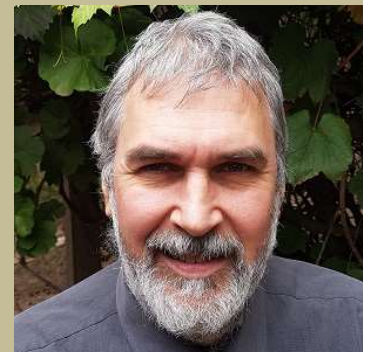


# Molecular confirmation of macrofungi distributions - exploratory analyses utilizing UNITE

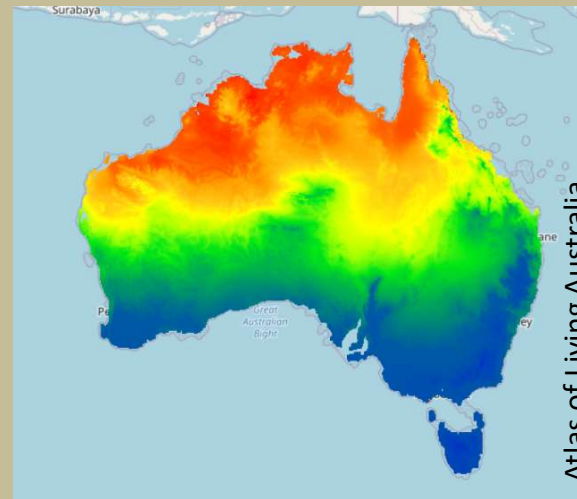


Russell Larke & Tom May  
*Royal Botanic Gardens Victoria*

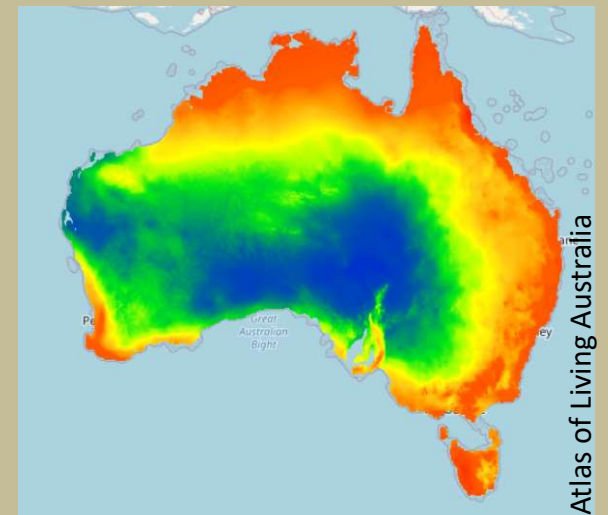


# Australia

Australia is large continent (4,000 km W to E) with large climate range



Annual mean temperature (BIO 1)



Annual mean precipitation (BIO 12)

# Data on Australian macrofungi

- Fungi distribution data aggregated in Atlas of Living Australia (supplied to GBIF)
- Active citizen science mapping scheme (Fungimap) and mobilization of fungarium data
- Some species with >2,000 observation + specimen records

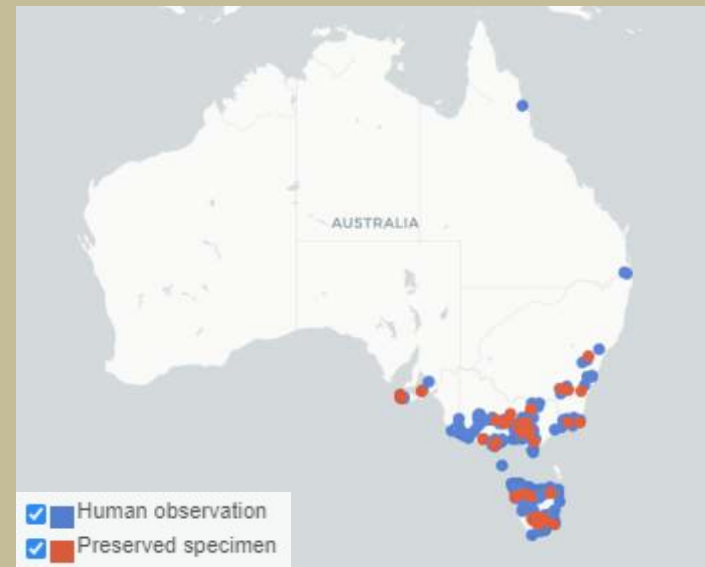


Fungi Down Under (2005)



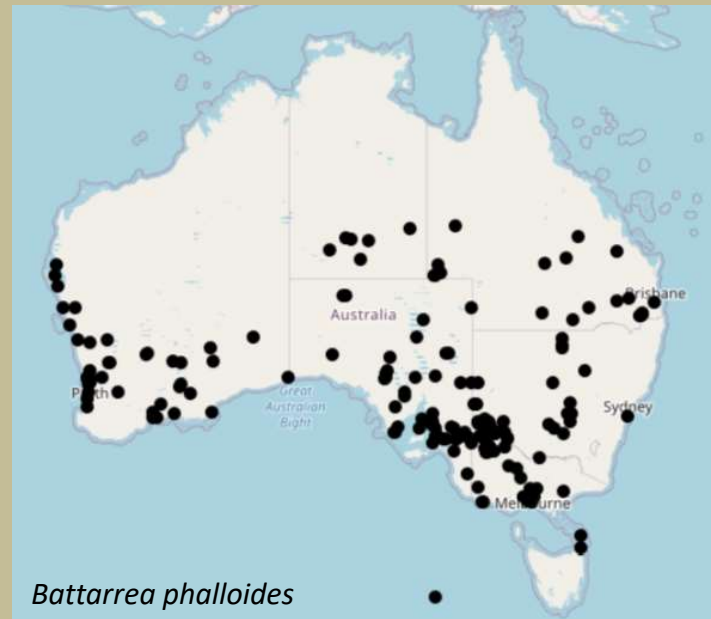
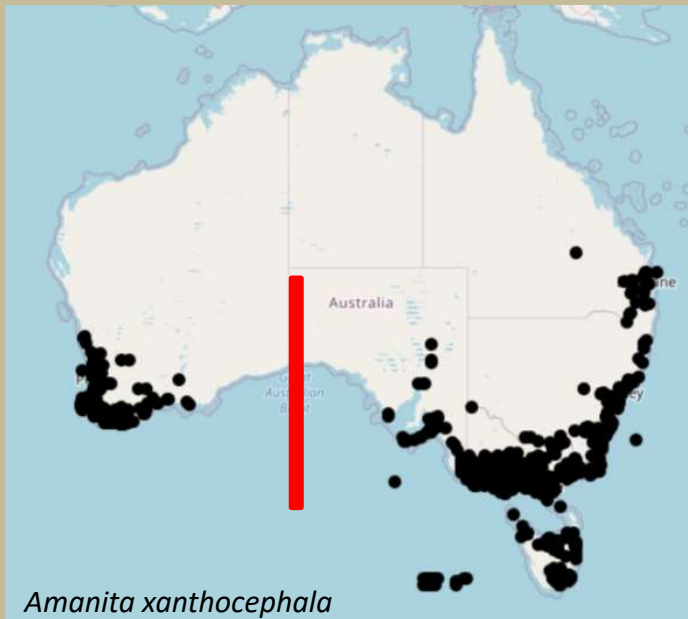
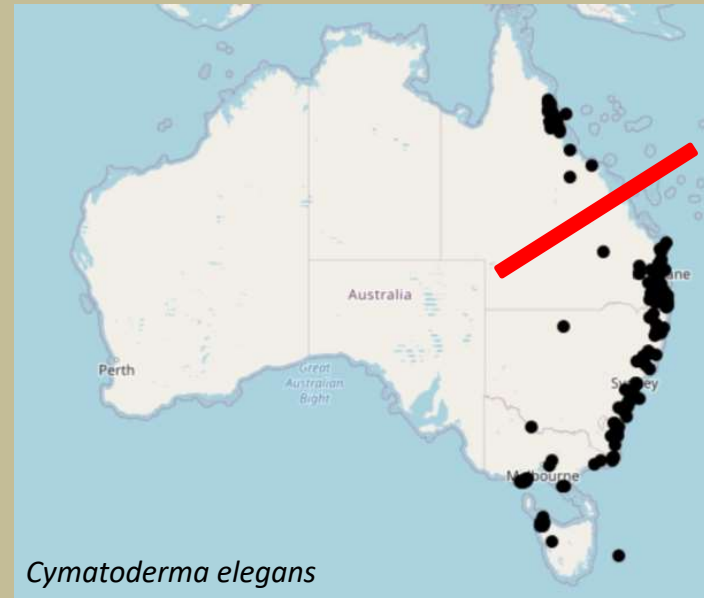
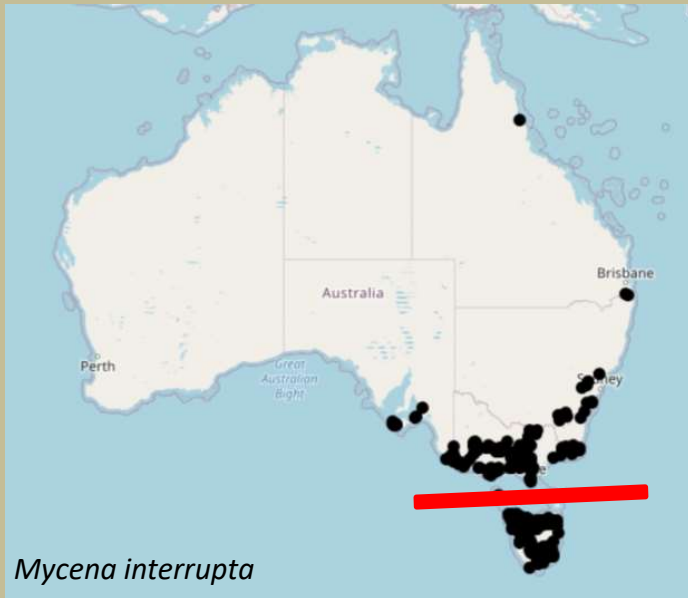
*Mycena interrupta*

CC BY John Walter



Atlas of Living Australia

# Australian macrofungi - wide distributions



## **AIM: Confirm wide distributions from molecular data**

- Select species with numerous sequences
- Ensure species are taxonomically rigorous
- Add geo-coordinates where missing
- Map

# PLUTO-f workbench

Plutof  My Menu Settings Tom.May Log out Est

☰ Data Management Plans  
🌐 Projects  
🗄️ TAXON OCCURRENCES  
📏 Traits and Measurements  
🔬 LABORATORIES  
📁 File Repository  
👤 Persons  
🏢 Organizations  
📄 Clipboard & Export  
📂 Import  
🔍 Search

🔍 Search Bookmark Info Reset Back

Search string   Search over all fields Module: Sequences Filters

**Active filters**  
Include subtaxa (Yes) ✖  
Taxon (Agaricales) ✖  
Country (Australia) ✖  
Sequence types (5.8S) ✖

List view Image view Map view Statistics

50  ⏪ 1 / 58 ⏩

Found 2886 results.

Top taxa	Top countries	Top isolation sources	Top rights holders
Cortinarius 847	Australia 2886	Fungus: Ectomycorrhiza 93	plutof 2743
Amanita 212		Fungus: Soil fungal DNA 44	Urmas Kõljalg 85
Inocybe 183		Fungus: Ericoid mycorrhiza 20	Leho Tedersoo 54
Laccaria 129		Fungus: Fruitbody 9	Irja Saar 2
Cortinariaceae 56		Fungus: Orchid mycorrhiza 4	Philipp Dresch 2
More...			

Cluster
UCL8_000003 678
UCL8_006776 161
UCL8_001721 103
UCL8_007783 67
UCL8_000156 54
More...

#	Record	Chimeric status	Compound clusters	Country	Geo-coordinates	ID	INSD taxon name	Sequence length	Sequence types	Species Hypothesis	Taxon	Add to clipboard
1	<input checked="" type="checkbox"/>	No		Australia		LT613599	uncultured Cortinarius	235	ITS1, 5.8S, ITS2		Cortinariaceae	+

<https://plutof.ut.ee/>

## Active filters

Include subtaxa (Yes) ✖

Taxon (Agaricales) ✖

Country (Australia) ✖

Sequence types (5.8S) ✖

# Provides UNITE SH, also - can see missing geo-coordinates

#	Record	Chimeric status	Compound clusters	Country	Geo-coordinates	ID	INSD taxon name	Sequence length	Sequence types	Species Hypothe
1		No	UCL8_010137	Australia		AF329912	<i>Armillaria luteobubalina</i>	699	ITS1, 5.8S, ITS2	SH1609675.08FU, S
2		No	UCL8_010137	Australia		AF329913	<i>Armillaria luteobubalina</i>	679	ITS1, 5.8S, ITS2	SH1458178.08FU, S
3		No	UCL8_003527	Australia		AF329914	<i>Armillaria pallidula</i>	664	ITS1, 5.8S, ITS2	SH1263518.08FU, S
4		No	UCL8_003527	Australia		AF329915	<i>Armillaria pallidula</i>	664	ITS1, 5.8S, ITS2	SH1883232.08FU, S
5		No	UCL8_003527	Australia		AF329916	<i>Armillaria fumosa</i>	658	ITS1, 5.8S, ITS2	SH1683095.08FU, S
6		No	UCL8_003527	Australia		AF329917	<i>Armillaria fumosa</i>	656	ITS1, 5.8S, ITS2	SH1883233.08FU, S
7		No	UCL8_003527	Australia		AF329918	<i>Armillaria fumosa</i>	656	ITS1, 5.8S, ITS2	SH1883233.08FU, S
8		No	UCL8_003527	Australia		AF329919	<i>Armillaria fumosa</i>	657	ITS1, 5.8S, ITS2	SH1384472.08FU, S
9		No	UCL8_003527	Australia		AF329920	<i>Armillaria fumosa</i>	658	ITS1, 5.8S, ITS2	SH1263518.08FU, S
10		No	UCL8_003527	Australia		AF329921	<i>Armillaria fumosa</i>	658	ITS1, 5.8S, ITS2	SH1384472.08FU, S
11		No	UCL8_001044	Australia		AF329922	<i>Armillaria novae-zelandiae</i>	739	ITS1, 5.8S, ITS2	SH1510659.08FU, S
12		No	UCL8_001044	Australia		AF329923	<i>Armillaria novae-zelandiae</i>	739	ITS1, 5.8S, ITS2	SH1510659.08FU, S
13		No	UCL8_001044	Australia		AF329924	<i>Armillaria novae-zelandiae</i>	739	ITS1, 5.8S, ITS2	SH1510659.08FU, S
14		No		Australia		AF389126 ZTact72567	<i>Cortinarius australiensis</i>	353	ITS1, 5.8S, ITS2	
15		No	UCL8_008937	Australia		AF407005	<i>Rhizoctonia</i> sp. TBR	581	ITS1, 5.8S, ITS2	SH1192112.08FU, S
16		No	UCL8_008937	Australia		AF407006	<i>Rhizoctonia</i> sp. TBR	607	ITS1, 5.8S, ITS2	SH1304168.08FU, S
17		No	UCL8_008937	Australia		AF407007	<i>Rhizoctonia</i> sp. TBR	504	ITS1, 5.8S, ITS2	SH1574432.08FU, S
18		No	UCL8_008937	Australia		AF407008	<i>Rhizoctonia</i> sp. TBR	609	ITS1, 5.8S, ITS2	SH1574432.08FU, S
19		No	UCL8_008937	Australia		AF407009	<i>Rhizoctonia</i> sp. TBR	587	ITS1, 5.8S, ITS2	SH1574432.08FU, S
20		No		Australia		AF454737	<i>Armillaria fumosa</i>	707	ITS1, 5.8S, ITS2	
21		No	UCL8_003527	Australia		AF454738	<i>Armillaria pallidula</i>	713	ITS1, 5.8S, ITS2	SH1683098.08FU, S
22		No	UCL8_001044	Australia		AF454739	<i>Armillaria novae-zelandiae</i>	785	ITS1, 5.8S, ITS2	SH2141206.08FU, S
23		No	UCL8_009216	Australia		AF454740	<i>Armillaria hinnulea</i>	802	ITS1, 5.8S, ITS2	SH1976084.08FU, S
24		No	UCL8_010137	Australia		AF454742	<i>Armillaria luteobubalina</i>	745	ITS1, 5.8S, ITS2	SH1793089.08FU, S
25		No	UCL8_010137	Australia		AF454743	<i>Armillaria luteobubalina</i>	745	ITS1, 5.8S, ITS2	SH2037526.08FU, S
26		No	UCL8_000003	Australia	POINT (150.5 -33.6)	AF461591	uncultured fungus	687	ITS1, 5.8S, ITS2	SH1857081.08FU, S
27		No	UCL8_003719	Australia	POINT (150.5 -33.6)	AF461593	uncultured fungus	692	ITS1, 5.8S, ITS2	SH1385898.08FU, S
28		No	UCL8_003719	Australia	POINT (150.5 -33.6)	AF461594	uncultured fungus	692	ITS1, 5.8S, ITS2	SH1385898.08FU, S
29		No	UCL8_005455	Australia	POINT (150.5 -33.6)	AF461614	uncultured fungus	676	ITS1, 5.8S, ITS2	SH1706638.08FU, S
30		No	UCL8_000003	Australia	POINT (150.5 -33.6)	AF461641	uncultured fungus	667	ITS1, 5.8S, ITS2	SH1504249.08FU, S

# Spreadsheet download from Pluto-f

Compound id	UNITE."3.0"	UNITE."2.5"	UNITE."2.0"	UNITE."1.5"	UNITE."1.0"	UNITE."0.5"
AF329916	SH1155001.08FU	SH1263518.08FU	SH1384472.08FU	SH1522042.08FU	SH1683095.08FU	SH1883232.08FU
AF329915	SH1155001.08FU	SH1263518.08FU	SH1384472.08FU	SH1522042.08FU	SH1683095.08FU	SH1883232.08FU
AF329914	SH1155001.08FU	SH1263518.08FU	SH1384472.08FU	SH1522042.08FU	SH1683095.08FU	SH1883232.08FU
AF329911	SH1211709.08FU	SH1327381.08FU	SH1458176.08FU	SH1609673.08FU	SH1793089.08FU	SH2037526.08FU
AF329908	SH1194301.08FU	SH1306670.08FU	SH1432847.08FU	SH1577902.08FU	SH1751010.08FU	SH1976037.08FU
AF249368	SH1185985.08FU	SH1297326.08FU	SH1422160.08FU	SH1565276.08FU	SH1735155.08FU	SH1953852.08FU
AF289063	SH1232769.08FU	SH1351427.08FU	SH1485968.08FU	SH1642540.08FU	SH1833919.08FU	SH2093958.08FU
AF289062	SH1232768.08FU	SH1351426.08FU	SH1485967.08FU	SH1642539.08FU	SH1833916.08FU	SH2093955.08FU
AF136738	SH1141402.08FU	SH1248762.08FU	SH1368304.08FU	SH1503903.08FU	SH1661953.08FU	SH1856328.08FU
AF112147	SH1141300.08FU	SH1248650.08FU	SH1368147.08FU	SH1503729.08FU	SH1661736.08FU	SH1855750.08FU
AF112146	SH1141780.08FU	SH1249187.08FU	SH1368732.08FU	SH1504365.08FU	SH1662421.08FU	SH1856487.08FU
AF112145	SH1141548.08FU	SH1248918.08FU	SH1368431.08FU	SH1504044.08FU	SH1662083.08FU	SH1856098.08FU
AF112144	SH1141402.08FU	SH1248762.08FU	SH1368304.08FU	SH1503903.08FU	SH1661953.08FU	SH1856328.08FU
AF112143	SH1141930.08FU	SH1249365.08FU	SH1368930.08FU	SH1504602.08FU	SH1662714.08FU	SH1856927.08FU
AF112142	SH1158534.08FU	SH1267443.08FU	SH1388993.08FU	SH1527298.08FU	SH1689639.08FU	SH1891886.08FU
U33076	SH1187600.08FU	SH1299104.08FU	SH1424154.08FU	SH1567537.08FU	SH1737848.08FU	SH1957415.08FU
FN550942	SH1230029.08FU	SH1348372.08FU	SH1482532.08FU	SH1638637.08FU	SH1829346.08FU	SH2088037.08FU
FN550934	SH1172487.08FU	SH1282161.08FU	SH1404783.08FU	SH1544658.08FU	SH1709330.08FU	SH1916297.08FU

## Cross tabulation of sequence counts under SH

Row Labels	Count of INSD original data.Organism	
SH001792.06FU	1	SH 3.0
SH149441.06FU	1	SH 2.5
SH040897.06FU	1	SH 2.0
SH192240.06FU	1	SH 1.5
uncultured fungus	1	



SH1141335.08FU	47
SH1248691.08FU	47
SH1368177.08FU	47
SH1503760.08FU	47
Cortinarius kula	12
Cortinarius sp.	33
Dermocybe kula	1
uncultured Dermocybe	1

Level 1 **4**    Level 2 **5**    Level 3 **11**    Level 4 **12**    Level 5 **20**    Level 6 **20**    Level 7 **32**    ⓘ

All sequences belonging to the SH are shown

Sequence ID	UNITE taxon name	INSD taxon name	Source	Interacting Taxa	Area	RefSeq	Actions	0.0	0.5	1.0	1.5	2.0	2.5	3.0
JF960753	Cortinarius	Cortinariaceae (uncultured Dermocybe)			Australia	—	×							
JN942283	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
JN942281	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
JN942282	Cortinarius	Dermocybe kula (Dermocybe kula)			Australia	—	×							
JX679136	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
JX679134	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
JX679119	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
JX679114	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
MG552955	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552951	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552948	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552947	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552903	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552869	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552868	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552867	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
JX679133	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
MG552949	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
JX178621	Cortinarius	Dermocybe kula (Dermocybe kula)			New Zealand	—	×							
MG552902	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MN846446	Cortinarius	Cortinarius (Cortinarius kula)			New Zealand	—	×							
MG552975	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
GQ890325	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
MG552973	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552950	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
JX679103	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
JX679122	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
MG553107	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552963	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552962	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
AY669643	Cortinarius	Cortinarius (Cortinarius kula)			Australia	—	×							
MG552946	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							

Cortinarius | SH1141335.08FU



# Example of “clean” group of sequences for *Cortinarius erythrocephalus* (but the SH also including some sequences id merely as *Cortinarius* sp.)

Level 1 **3**    Level 2 **3**    Level 3 **12**    Level 4 **12**    Level 5 **17**    Level 6 **17**    Level 7 **29**    ⓘ

All sequences belonging to the SH are shown

Sequence ID	UNITE taxon name	INSD taxon name	Source	Interacting Taxa	Area	RefSeq	Actions	0.0	0.5	1.0	1.5	2.0	2.5	3.0
GQ890327	Cortinarius	Cortinarius (Cortinarius aff. persplendidus 2 FS-2012)			Australia	—	×							
MG552960	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552959	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552957	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552925	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552921	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552918	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552915	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
JX679113	Cortinarius	Cortinarius (Cortinarius aff. persplendidus 2 FS-2012)			Australia	—	×							
MG552919	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552916	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
JN942288	Cortinarius	Dermocybe splendida (Dermocybe splendida)			Australia	—	×							
MG552958	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552923	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
JX679124	Cortinarius	Cortinarius (Cortinarius aff. persplendidus 1 FS-2012)			Australia	—	×							
JN942289	Cortinarius	Cortinarius (Cortinarius aff. persplendidus 1 FS-2012)			Australia	—	×							
JX679127	Cortinarius	Cortinarius (Cortinarius aff. persplendidus 1 FS-2012)			Australia	—	×							
MG552917	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
JN942295	Cortinarius erythrocephalus	Cortinarius erythrocephalus (Cortinarius erythrocephalus)			Australia	—	×							
JN942294	Cortinarius erythrocephalus	Cortinarius erythrocephalus (Cortinarius erythrocephalus)			Australia	—	×							
JX679121	Cortinarius erythrocephalus	Cortinarius erythrocephalus (Cortinarius erythrocephalus)			Australia	—	×							
MG553108	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552952	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552990	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552904	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
GQ890323	Cortinarius erythrocephalus	Cortinarius erythrocephalus (Cortinarius erythrocephalus)			Australia	—	×							
JX679145	Cortinarius erythrocephalus	Cortinarius erythrocephalus (Cortinarius erythrocephalus)			Australia	—	×							
MG552945	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							
MG552905	Cortinarius	Cortinarius (Cortinarius sp.)			Australia	—	×							

Example where one SH contains sequences under two names,  
one presumably is mis-applied

Level 1 **1**    Level 2 **1**    Level 3 **4**    Level 4 **4**    Level 5 **6**    ⓘ

Identical sequences for the same continent collapsed

Sequence ID	UNITE taxon name	INSD taxon name	Source	Interacting Taxa	Area	RefSeq	Actions	0.0	0.5	1.0	1.5	2.0	2.5	3.0
KX443411	<a href="#">Limacella</a>	<a href="#">Limacella (Limacella pitereka)</a>			Australia	—	<b>x</b>							
MH508661	<a href="#">Limacella ochraceolutea</a>	<a href="#">Limacella ochraceolutea (Limacella ochraceolutea)</a>			Australia	—	<b>x</b>							
MH508660	<a href="#">Limacella ochraceolutea</a>	<a href="#">Limacella ochraceolutea (Limacella ochraceolutea)</a>			Australia	—	<b>x</b>							
MH508663	<a href="#">Limacella ochraceolutea</a>	<a href="#">Limacella ochraceolutea (Limacella ochraceolutea)</a>			Australia	—	<b>x</b>							
KX443412	<a href="#">Limacella</a>	<a href="#">Limacella (Limacella pitereka)</a>			Australia	—	<b>x</b>							
MH508662	<a href="#">Limacella ochraceolutea</a>	<a href="#">Limacella ochraceolutea (Limacella ochraceolutea)</a>			Australia	—	<b>x</b>							

## BLAST – clear disjunction in percentage identity between sequences of target species and the “next” species

	Description	Scientific Name	Max Score	Total Score	Query Cover	E value	Per. Ident	Acc. Len	Accession
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria voucher OTA:62344 small subunit ribosomal RNA gene, partial sequence; internal transcrib...</a>	<a href="#">Cortinarius canar...</a>	1149	1149	100%	0.0	100.00%	678	<a href="#">MN846383.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria isolate JAC16231 small subunit ribosomal RNA gene, partial sequence; internal transcribed...</a>	<a href="#">Cortinarius canar...</a>	1149	1149	100%	0.0	100.00%	705	<a href="#">MW263859.1</a>
<input checked="" type="checkbox"/>	<a href="#">Uncultured Cortinarius clone BH1594F internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gen...</a>	<a href="#">uncultured Cortin...</a>	1149	1149	100%	0.0	100.00%	622	<a href="#">JF960665.1</a>
<input checked="" type="checkbox"/>	<a href="#">Cortinarius cannarius voucher HO A20511C4 18S ribosomal RNA gene, partial sequence; internal transcribed sp...</a>	<a href="#">Cortinarius canar...</a>	1149	1149	100%	0.0	100.00%	1245	<a href="#">AY669630.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria isolate JAC11109 small subunit ribosomal RNA gene, partial sequence; internal transcribed...</a>	<a href="#">Cortinarius canar...</a>	1147	1147	99%	0.0	100.00%	640	<a href="#">MW263667.1</a>
<input checked="" type="checkbox"/>	<a href="#">Cortinarius sp. isolate df117 Ccan internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene an...</a>	<a href="#">Cortinarius sp.</a>	1144	1144	99%	0.0	100.00%	648	<a href="#">MG552882.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria isolate JAC15236 small subunit ribosomal RNA gene, partial sequence; internal transcribed...</a>	<a href="#">Cortinarius canar...</a>	1144	1144	100%	0.0	99.84%	683	<a href="#">MW263801.1</a>
<input checked="" type="checkbox"/>	<a href="#">Uncultured fungus clone DA0320A 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5...</a>	<a href="#">uncultured fungus</a>	1144	1144	100%	0.0	99.84%	668	<a href="#">GQ906437.1</a>
<input checked="" type="checkbox"/>	<a href="#">Cortinarius sp. isolate df118 Ccan internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene an...</a>	<a href="#">Cortinarius sp.</a>	1140	1140	99%	0.0	99.84%	637	<a href="#">MG552883.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria strain MEL2257844 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA ge...</a>	<a href="#">Cortinarius canar...</a>	1140	1140	99%	0.0	99.84%	637	<a href="#">JN942306.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria voucher OTA:61894 small subunit ribosomal RNA gene, partial sequence; internal transcrib...</a>	<a href="#">Cortinarius canar...</a>	1138	1138	100%	0.0	99.68%	678	<a href="#">MN846382.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria voucher PDD:88999 18S ribosomal RNA gene, partial sequence; internal transcribed spacer...</a>	<a href="#">Cortinarius canar...</a>	1138	1138	100%	0.0	99.68%	668	<a href="#">GU222286.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria voucher OTA:70580 small subunit ribosomal RNA gene, partial sequence; internal transcrib...</a>	<a href="#">Cortinarius canar...</a>	1134	1134	100%	0.0	99.52%	678	<a href="#">MN846385.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria voucher MEL2089670 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA...</a>	<a href="#">Cortinarius canar...</a>	1131	1131	99%	0.0	99.68%	636	<a href="#">JX679151.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria strain df027 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene, com...</a>	<a href="#">Cortinarius canar...</a>	1127	1127	99%	0.0	99.68%	615	<a href="#">GQ890320.2</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria strain df027 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene, com...</a>	<a href="#">Cortinarius canar...</a>	1125	1125	99%	0.0	99.68%	615	<a href="#">JN942305.1</a>
<input checked="" type="checkbox"/>	<a href="#">Dermocybe canaria voucher MEL2060416 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA...</a>	<a href="#">Cortinarius canar...</a>	1079	1079	94%	0.0	99.66%	589	<a href="#">JX679152.1</a>
<input type="checkbox"/>	<a href="#">Cortinarius elaiops voucher OTA:64133 small subunit ribosomal RNA gene, partial sequence; internal transcribe...</a>	<a href="#">Cortinarius elaiops</a>	1018	1018	100%	0.0	96.16%	681	<a href="#">MN846420.1</a>
<input type="checkbox"/>	<a href="#">Cortinarius elaiops PDD 88271 ITS region; from TYPE material</a>	<a href="#">Cortinarius elaiops</a>	1014	1014	100%	0.0	96.01%	676	<a href="#">NR_157903.1</a>
<input type="checkbox"/>	<a href="#">Cortinarius elaiops voucher PDD:88271 18S ribosomal RNA gene, partial sequence; internal transcribed spacer...</a>	<a href="#">Cortinarius elaiops</a>	1014	1014	100%	0.0	96.01%	676	<a href="#">JX000369.1</a>
<input type="checkbox"/>	<a href="#">Cortinarius alienatus voucher PDD:72630 small subunit ribosomal RNA gene, partial sequence; internal transcri...</a>	<a href="#">Cortinarius alien...</a>	1011	1011	100%	0.0	95.99%	701	<a href="#">MH101620.1</a>
<input type="checkbox"/>	<a href="#">Cortinarius elaiops voucher PDD:107732 18S ribosomal RNA gene, partial sequence; internal transcribed space...</a>	<a href="#">Cortinarius elaiops</a>	1011	1011	100%	0.0	95.85%	1658	<a href="#">KT875181.1</a>
<input type="checkbox"/>	<a href="#">Cortinarius sp. KL-2018h voucher K:235093 small subunit ribosomal RNA gene, partial sequence; internal transc...</a>	<a href="#">Cortinarius subru...</a>	1009	1009	100%	0.0	95.85%	698	<a href="#">MF568560.1</a>

Cortinariaceae | SH1141375.08FU

Level 1 **1**

Level 2 **2**

Level 3 **10**

Level 4 **11**

Level 5 **14**

Level 6 **14**

Level 7 **15**



All sequences belonging to the SH are shown

Sequence ID	UNITE taxon name	INSD taxon name	Source	Area	RefSeq	0.0	0.5	1.0	1.5	2.0	2.5	3.0
AY669630	Cortinarius	Cortinarius (Cortinarius cannarius)		Australia	—							
JF960665	Cortinarius	Cortinariaceae (uncultured Cortinarius)		Australia	—							
MG552882	Cortinarius	Cortinarius (Cortinarius sp.)		Australia	—							
MN846384	Dermocybe canaria	Dermocybe canaria (Dermocybe canaria)		New Zealand	—							
MN846383	Dermocybe canaria	Dermocybe canaria (Dermocybe canaria)		New Zealand	—							
JN942305	Cortinarius	Dermocybe canaria (Dermocybe canaria)		Australia	—							
JX679151	Cortinarius	Dermocybe canaria (Dermocybe canaria)		Australia	—							
GU222286	Cortinarius	Dermocybe canaria (Dermocybe canaria)		New Zealand	—							
GQ890320	Cortinarius	Dermocybe canaria (Dermocybe canaria)		Australia	—							
JN942306	Cortinarius	Dermocybe canaria (Dermocybe canaria)		Australia	—							
MG552883	Cortinarius	Cortinarius (Cortinarius sp.)		New Zealand	—							
GQ906437	Cortinarius	Fungi (uncultured fungus)	Ectomycorrhiza	New Zealand	—							
JX679152	Cortinarius	Dermocybe canaria (Dermocybe canaria)		Australia	—							
MN846385	Dermocybe canaria	Dermocybe canaria (Dermocybe canaria)		New Zealand	—							
MN846382	Dermocybe canaria	Dermocybe canaria (Dermocybe canaria)		New Zealand	—							

## BLAST – lack of clear disjunction in percentage identity between sequences of target species and the “next” species

	Description	Scientific Name	Max Score	Total Score	Query Cover	E value	Per. Ident	Acc. Len	Accession
<input type="checkbox"/>	<a href="#">Stephanospora sheoak MEL 2305133 28S rRNA gene, partial sequence, from TYPE material</a>	<a href="#">Stephanospora s...</a>	1609	1609	100%	0.0	100.00%	871	<a href="#">NG_059975.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora sheoak isolate Tle1378 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora s...</a>	1609	1609	100%	0.0	100.00%	871	<a href="#">KM086987.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora sheoak isolate Tle1263 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora s...</a>	1604	1604	100%	0.0	99.89%	871	<a href="#">KM086992.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora sheoak isolate Tle1375 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora s...</a>	1602	1602	99%	0.0	100.00%	867	<a href="#">KM086988.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora sheoak isolate Tle1214 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora s...</a>	1596	1596	100%	0.0	99.77%	870	<a href="#">KM086990.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora sheoak isolate Tle1374 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora s...</a>	1596	1596	99%	0.0	99.88%	867	<a href="#">KM086989.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora sheoak isolate Tle1365 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora s...</a>	1580	1580	99%	0.0	99.54%	867	<a href="#">KM086950.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora poropingao isolate Tle1352 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora ...</a>	1578	1578	99%	0.0	99.54%	866	<a href="#">KM086944.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora poropingao PDD 103566 28S rRNA gene, partial sequence, from TYPE material</a>	<a href="#">Stephanospora ...</a>	1572	1572	99%	0.0	99.42%	866	<a href="#">NG_059528.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora poropingao isolate Tle1341 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora ...</a>	1572	1572	99%	0.0	99.42%	866	<a href="#">KM086947.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora novae-caledoniae OSC KH-NC04-011 28S rRNA gene, partial sequence, from TYPE material</a>	<a href="#">Stephanospora ...</a>	1568	1568	100%	0.0	99.20%	870	<a href="#">NG_059971.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora novae-caledoniae isolate Tle1281 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora ...</a>	1568	1568	100%	0.0	99.20%	870	<a href="#">KM086923.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora cribbae isolate Tle1347 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora c...</a>	1565	1565	100%	0.0	99.08%	871	<a href="#">KM086986.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora cribbae isolate Tle1265 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora c...</a>	1565	1565	100%	0.0	99.08%	872	<a href="#">KM086964.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora novae-caledoniae isolate Tle1279 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora ...</a>	1563	1563	100%	0.0	99.08%	869	<a href="#">KM086929.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora novae-caledoniae isolate Tle1275 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora ...</a>	1563	1563	100%	0.0	99.08%	870	<a href="#">KM086925.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora poropingao isolate Tle1181 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora ...</a>	1561	1561	98%	0.0	99.42%	860	<a href="#">KM086945.1</a>
<input type="checkbox"/>	<a href="#">Stephanospora cribbae isolate Tle1264 25S ribosomal RNA gene, partial sequence</a>	<a href="#">Stephanospora c...</a>	1559	1559	100%	0.0	98.97%	872	<a href="#">KM086968.1</a>

# Example of sequence not placed in same SH as other sequences under the same name

## Agaricales | UCL8\_007763

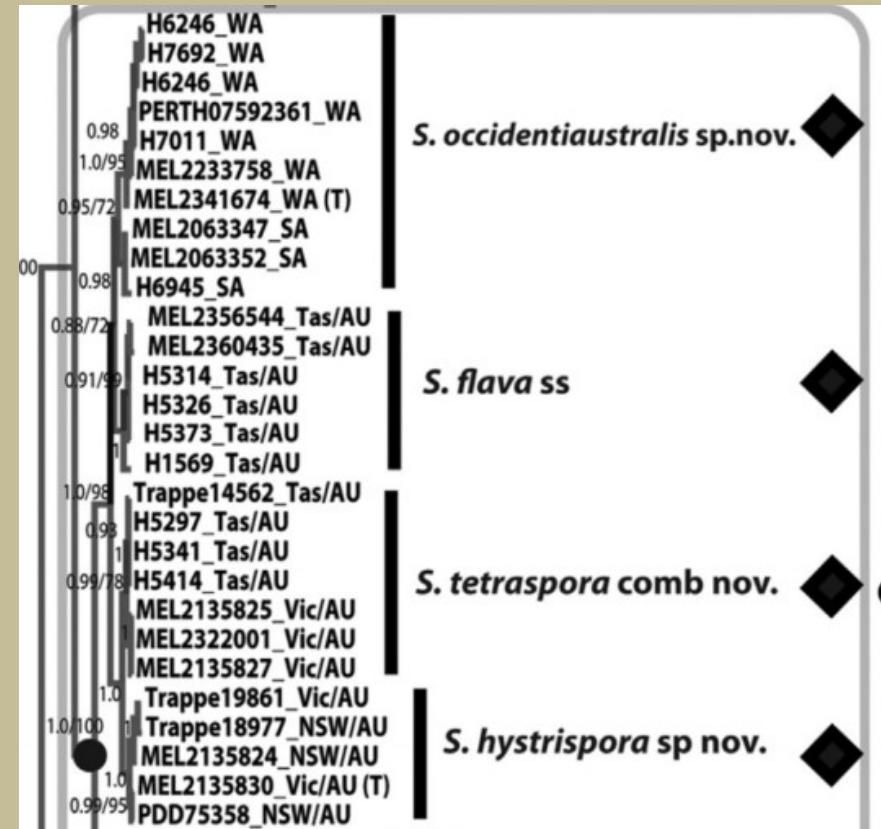
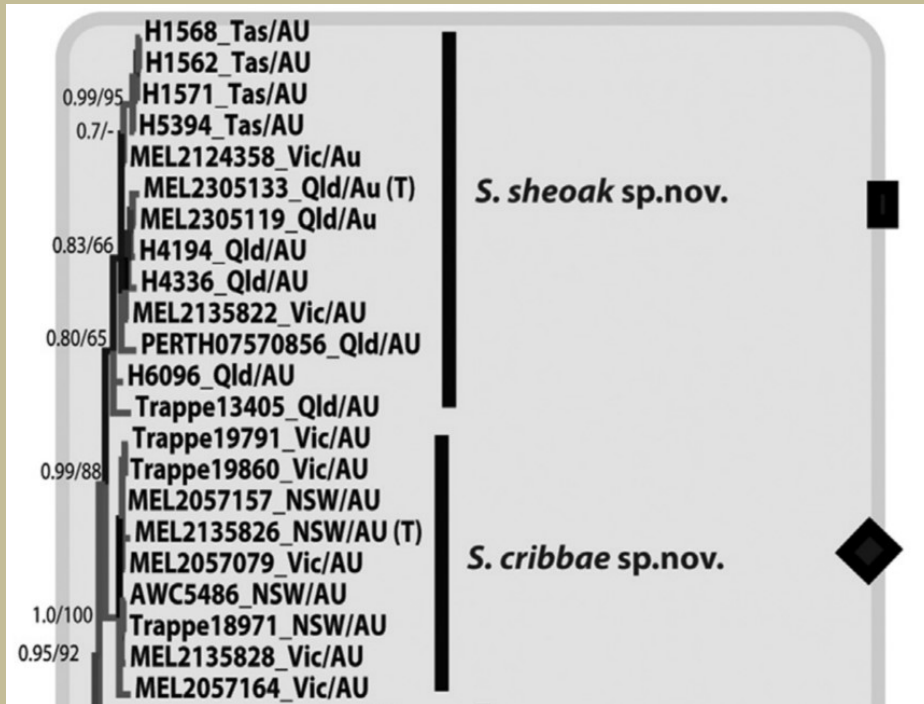
Accession Number	Unite Taxon Name	INSD Taxon Name	Source	Interacting Taxa	Area	
KM086861		Stephanospora flava			Australia	0.0
KM086860		Stephanospora flava			Australia	0.5
KM086863		Stephanospora flava			Australia	1.0
KM086862		Stephanospora flava			Australia	1.5
KM086864		Stephanospora flava			Australia	2.0
KM086885		Stephanospora occidentiaustralis			Australia	2.5
KM086884		Stephanospora occidentiaustralis			Australia	3.0
KM086883		Stephanospora occidentiaustralis			Australia	
KM086882		Stephanospora occidentiaustralis			Australia	
KM086887		Stephanospora occidentiaustralis			Australia	
KM086888		Stephanospora occidentiaustralis			Australia	
KM086870		<b>Stephanospora flava</b>			<b>Australia</b>	
KM086904		Stephanospora occidentiaustralis			Australia	
KM086886		Stephanospora occidentiaustralis			Australia	
KM086905		Stephanospora hystrispora			Australia	
KM086903		Stephanospora hystrispora			Australia	
KM086902		Stephanospora hystrispora			Australia	
KM086901	Stephanospora hystrispora	Stephanospora hystrispora			Australia	
KM086865		Stephanospora hystrispora			Australia	
KM086880		Stephanospora tetraspora			Australia	
KM086879		Stephanospora tetraspora			Australia	
KM086878		Stephanospora tetraspora			Australia	
KM086869		Stephanospora tetraspora			Australia	
KM086868		Stephanospora tetraspora			Australia	
KM086867		Stephanospora tetraspora			Australia	
KM086866		Stephanospora tetraspora			Australia	



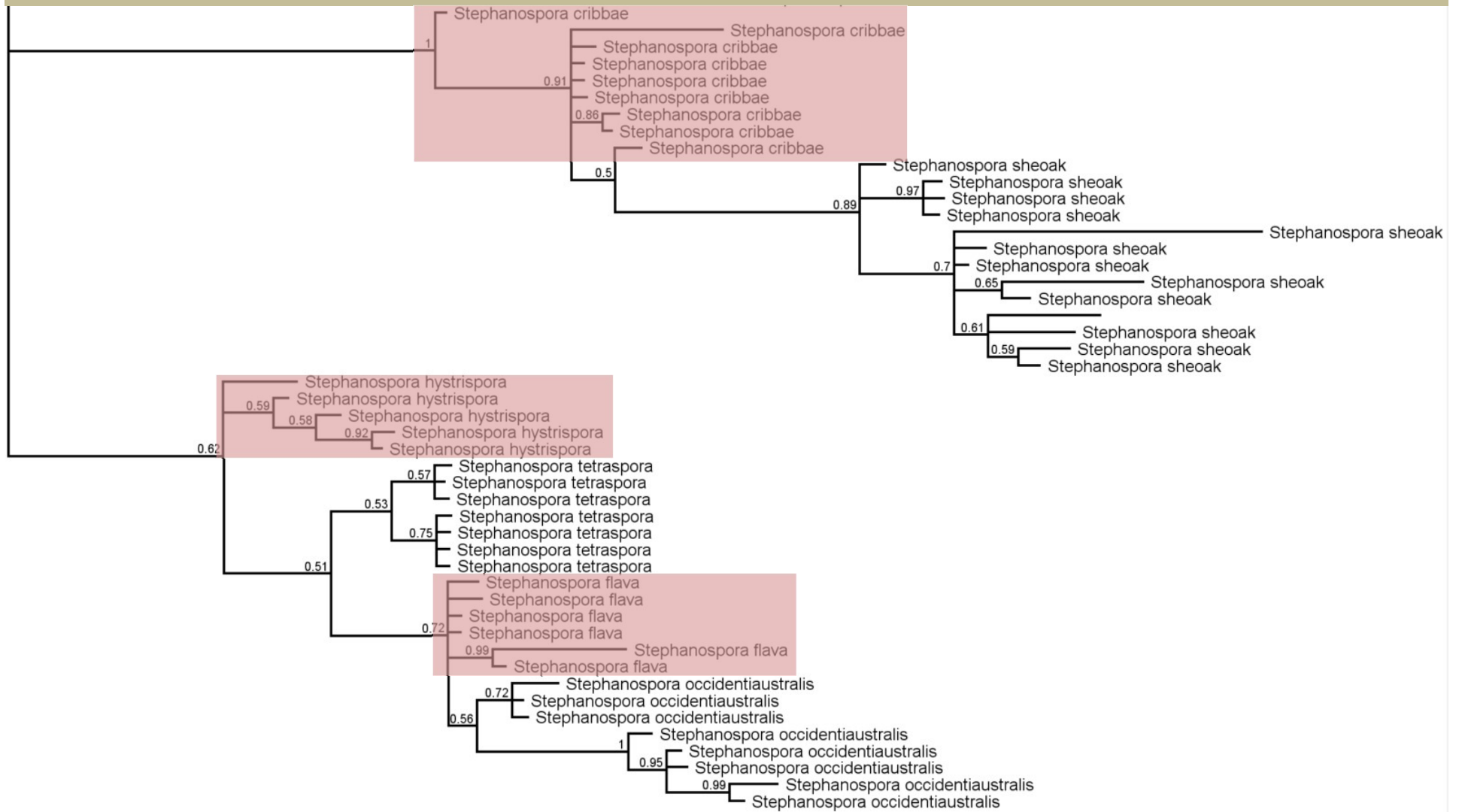
# Examples of sequences not placed in same SH as other sequences under the same name

Accession Number	Unite Taxon Name	INSD Taxon Name	Source	Interacting Taxa	Area	0.0	0.5	1.0	1.5	2.0	2.5	3.0
KM086867	Stephanospora sheoak	Stephanospora tetraspora	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086866		Stephanospora tetraspora	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086896		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086898		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086900		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086892		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086897		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086893		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086899		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086856		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086855		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086854		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086857		Stephanospora sheoak	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086891		Stephanospora cribbae	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086875		Stephanospora cribbae	Australia			0.5	1.0	1.5	2.0	2.5	3.0	
KM086871	Stephanospora cribbae	Australia			0.5	1.0	1.5	2.0	2.5	3.0		
KM086889	Stephanospora cribbae	Australia			0.5	1.0	1.5	2.0	2.5	3.0		
KM086872	Stephanospora cribbae	Australia			0.5	1.0	1.5	2.0	2.5	3.0		
KM086874	Stephanospora cribbae	Australia			0.5	1.0	1.5	2.0	2.5	3.0		
KM086890	Stephanospora cribbae	Australia			0.5	1.0	1.5	2.0	2.5	3.0		
KM086873	Stephanospora cribbae	Australia			0.5	1.0	1.5	2.0	2.5	3.0		
KM086876	Stephanospora	Spain			0.5	1.0	1.5	2.0	2.5	3.0		
KM086877	Stephanospora	United States			0.5	1.0	1.5	2.0	2.5	3.0		
KM086881	Stephanospora	Belize			0.5	1.0	1.5	2.0	2.5	3.0		
KM086895	Stephanospora cribbae	Australia			0.5	1.0	1.5	2.0	2.5	3.0		

# Stephanospora species are supported in multi-gene analysis



# *Stephanospora* species not strictly monophyletic on ITS only



# Same species can fall across >1 SH

Level 1 **11** Level 2 **11** Level 3 **12** ⓘ

Sequences within the same 0.5% SH for the same continent collapsed

Sequence ID	UNITE taxon name	INSD taxon name	Source	Area	RefSeq	Actions	0.0	0.5	1.0	1.5	2.0	2.5	3.0
KP137084	Amanita	Amanita (Amanita sp. AD-C54481)	Australia	—	—	×							
MN894326	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894325	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894324	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894323	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894322	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894294	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894293	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894292	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894291	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894310	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894308	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							

Amanita | SH1245581.08FU

Level 1 **10** Level 2 **10** Level 3 **18** ⓘ

Sequences within the same 0.5% SH for the same continent collapsed

Sequence ID	UNITE taxon name	INSD taxon name	Source	Area	RefSeq	Actions	0.0	0.5	1.0	1.5	2.0	2.5	3.0
MN894321	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894320	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894305	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894303	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894302	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894300	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894299	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894296	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894297	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894295	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894318	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894307	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894306	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894304	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894319	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894317	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894301	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							
MN894298	Amanita	Amanita (Amanita peltigera)	Australia	—	—	×							

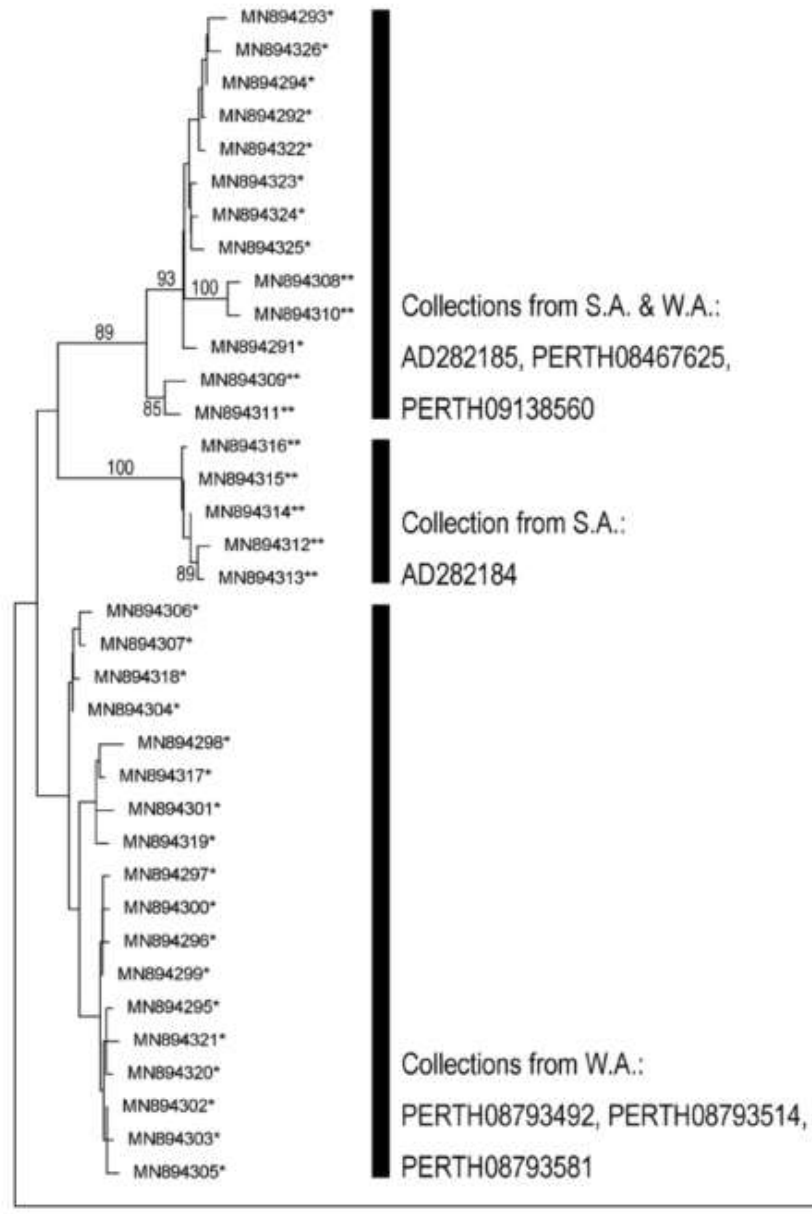
Amanita | SH3566360.08FU

# Compound cluster

Agaricales | UCL8\_020305

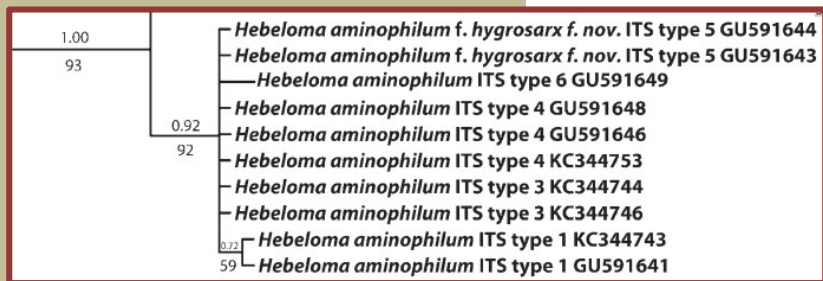
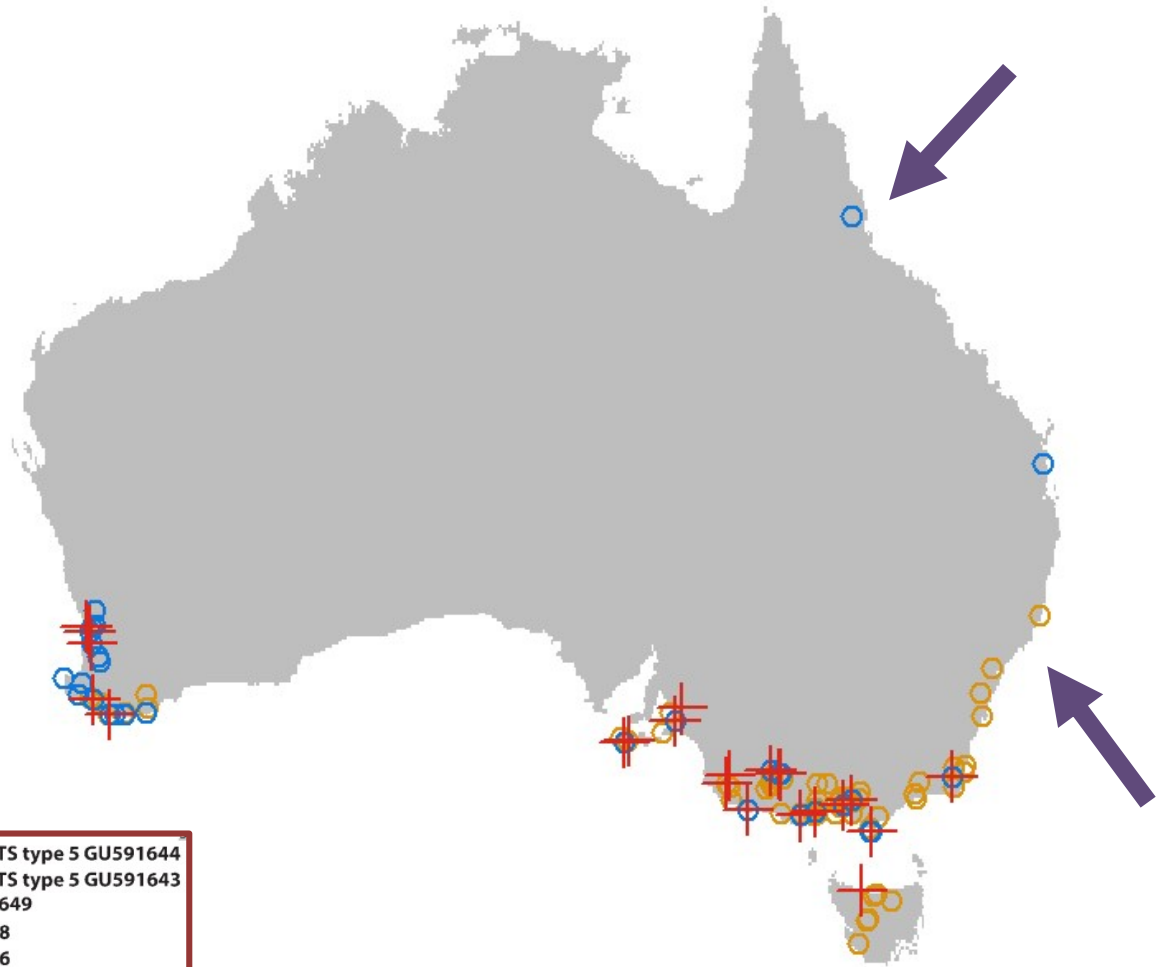
Accession Number	Unite Taxon Name	INSD Taxon Name	Source	Interacting Taxa	Area
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MN894324		Amanita			1.5
MN894323		Amanita			2.0
MN894322		Amanita			2.5
MN894294		Amanita			3.0
MN894293		Amanita			
MN894292		Amanita			
MN894291		Amanita			
MN894310		Amanita			
MN894308		Amanita			
MN894321		Amanita			
MN894320		Amanita			
MN894305		Amanita			
MN894303		Amanita			
MN894302		Amanita			
MN894300		Amanita			
MN894299		Amanita			
MN894296		Amanita			
MN894297		Amanita			
MN894295		Amanita			
MN894318		Amanita			
MN894307		Amanita			
MN894306		Amanita			
MN894304		Amanita			
MN894319		Amanita			
MN894317		Amanita			
MN894301		Amanita			
MN894298		Amanita			
MN894316		Amanita			
MN894315		Amanita			
MN894314		Amanita			
MN894313		Amanita			
MN894312		Amanita			

*Amanita peltigera*  
ITS



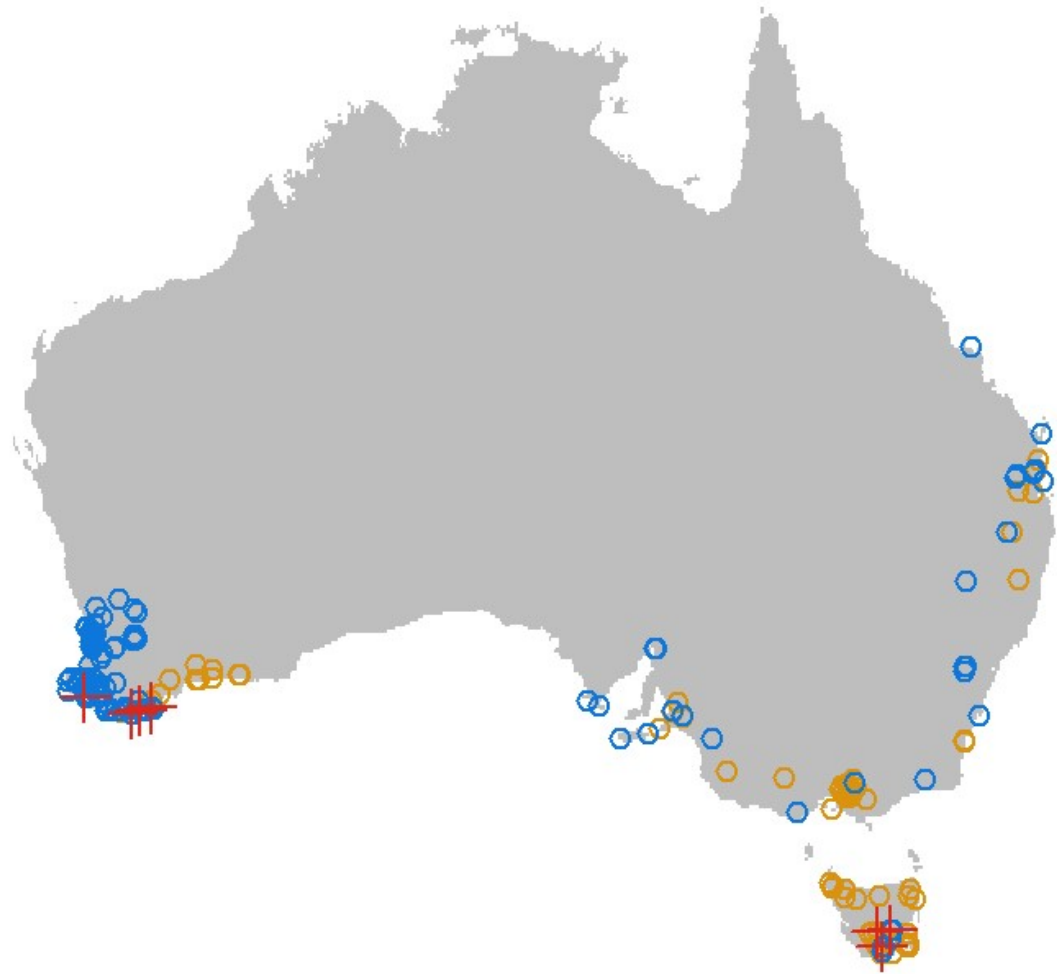


# *Hebeloma aminophilum*



Rees et al. (2013) Mycologia 105, 1043

*Inocybe australiensis*

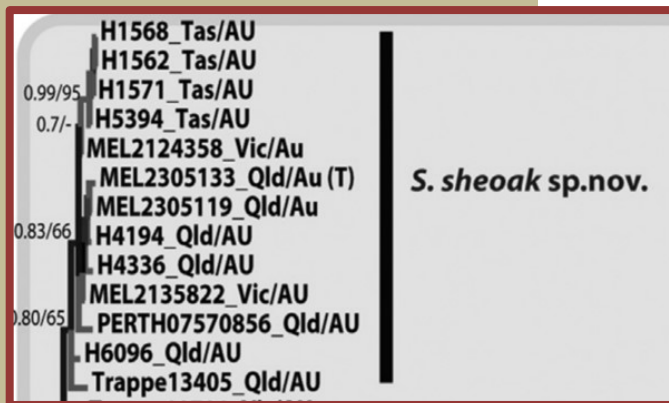
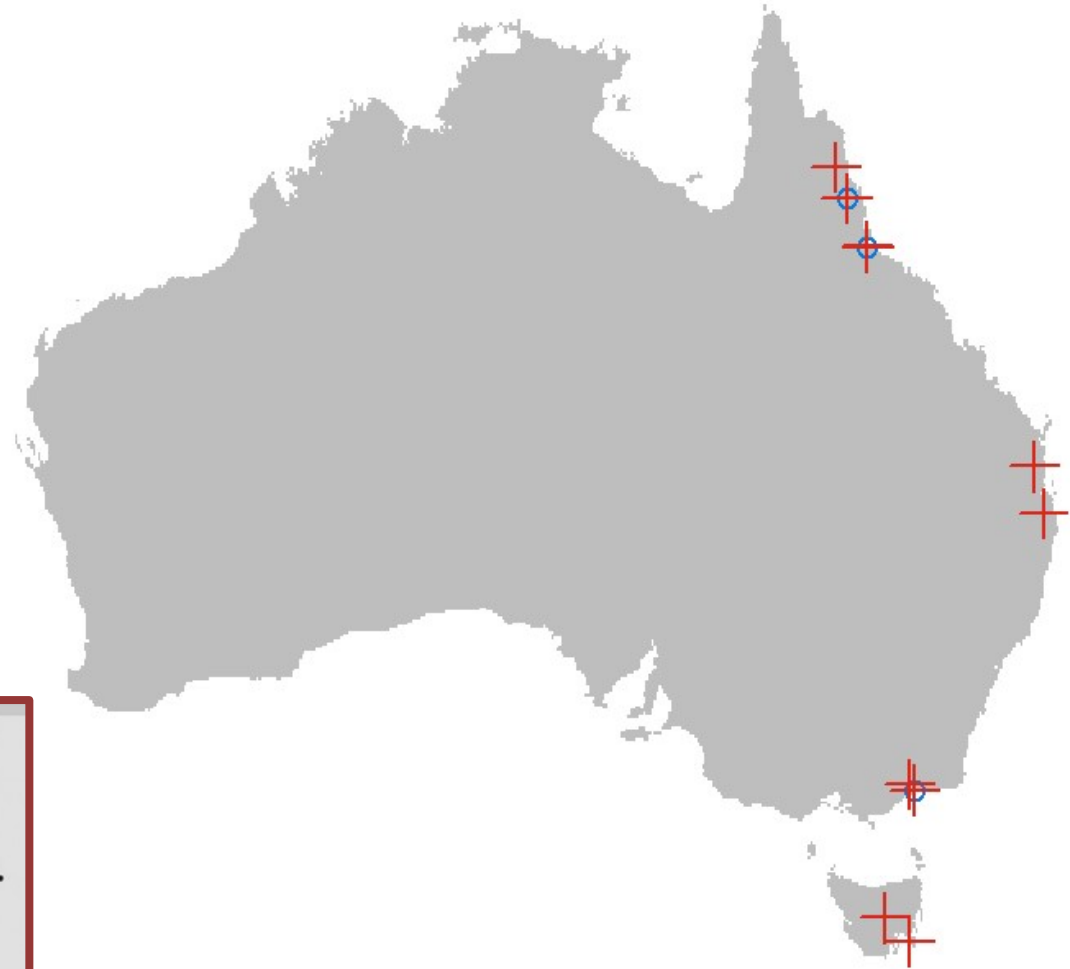




# *Stephanospora sheoak*



Image: T.Lebel



*Amanita hiltonii*



*Amanita wadulawitu*



*Amanita basiorubra*



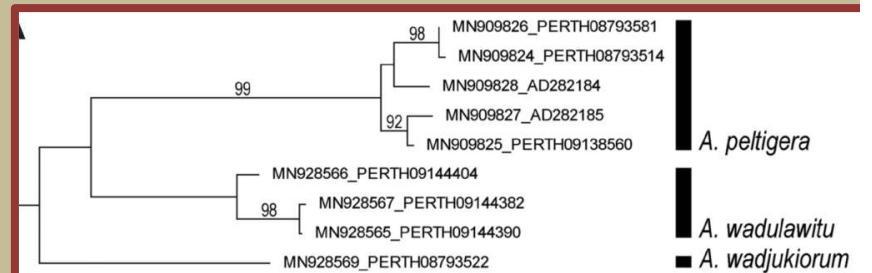
*Macrolepiota turbinata*



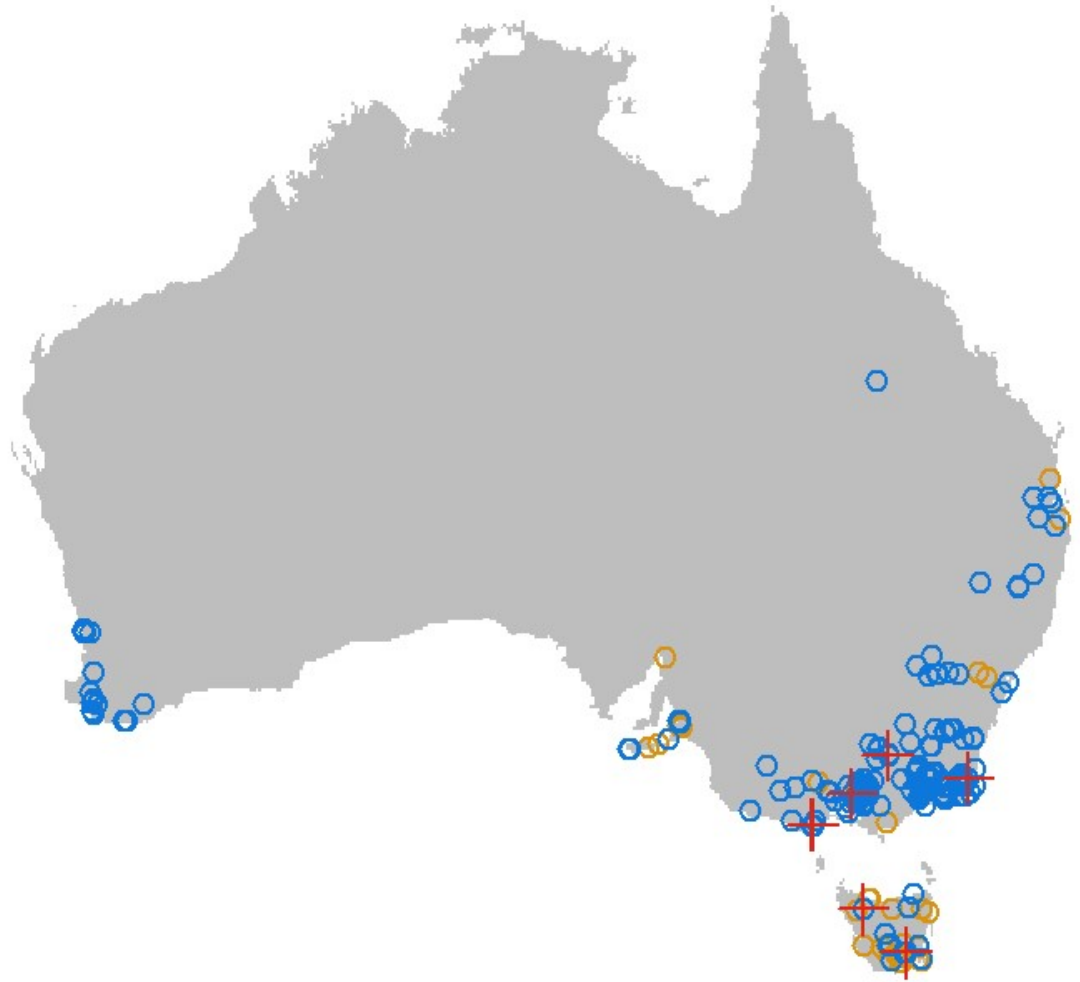
*Amanita peltigera*



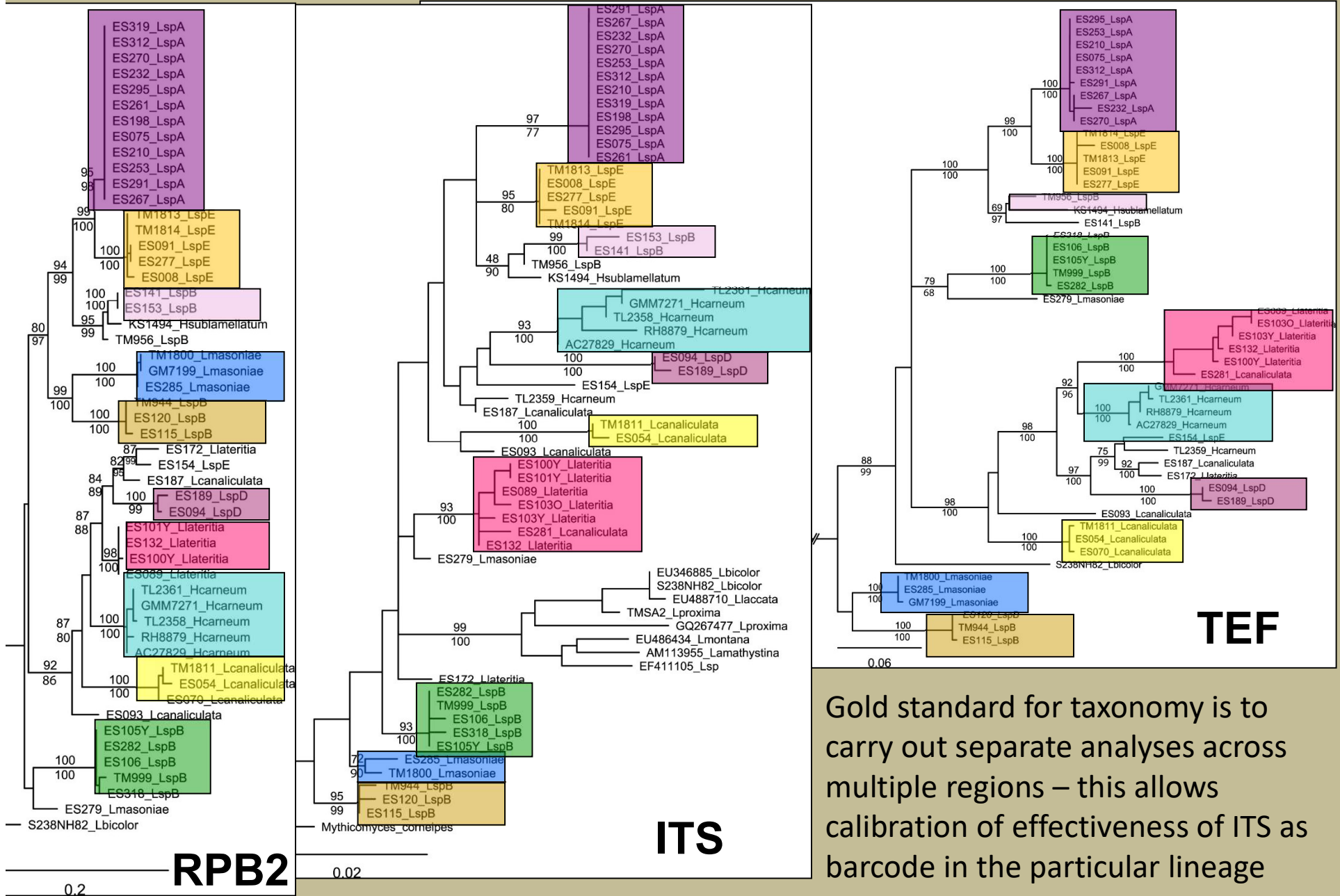
Davison et al. (2020) Swainsona 33, 51



*Hydnangium carneum*



# Genealogical concordance



Gold standard for taxonomy is to carry out separate analyses across multiple regions – this allows calibration of effectiveness of ITS as barcode in the particular lineage

# Bioclimatic modelling

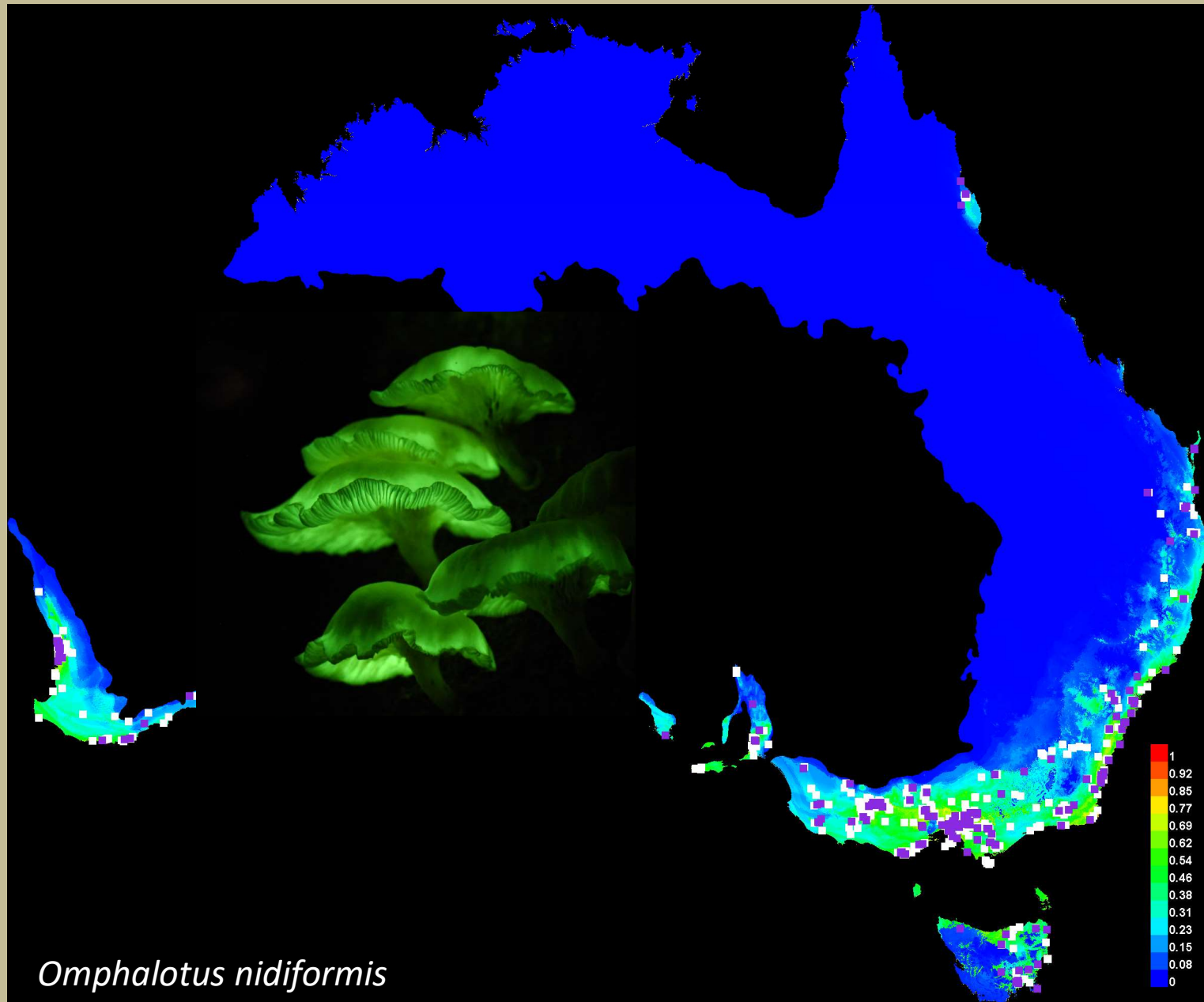
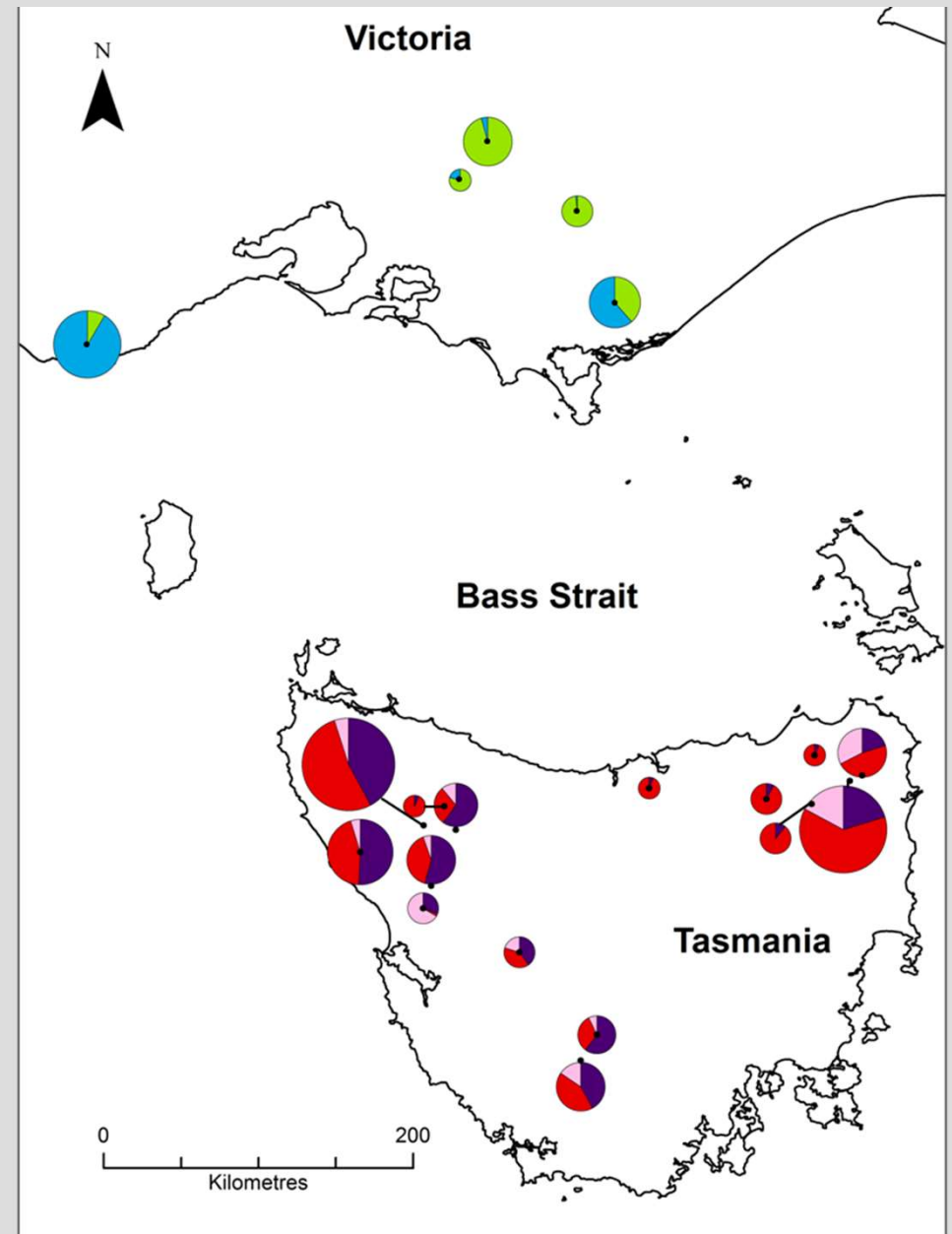
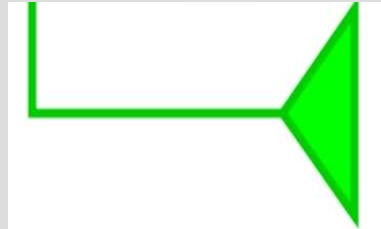


Image *O. nidiformis* – CC BY-NC discover-gondwana

Model is  
MaxEnt  
on  
climate  
variables

# Genetic structure within distribution

- *Laccaria* “sp. A”
- microsatellites
- 20 populations



Sheedy et al. (2015) *Fungal Ecology* 13, 23

# Conclusions

- Apparent wide distributions of Australian macrofungi confirmed by DNA sequence data
  - Many outliers still to check
  - Assess distribution when selecting specimens for sequencing
- Biogeography must be under-pinned by sound taxonomy [concordance across genes]
- High quality metadata is useful (and hard to back-engineer)

# Conclusions

- UNITE useful as exploratory tool
  - Detect un-named sequences that fall within the taxon of interest
  - Locate SHs with many members (even if not identified to species)
  - Alert to cross-continent distributions
  - Alert to species that are not distinguishable on ITS alone
  - Alert to care with using set thresholds
- Bring on the metabarcoding data!!